

The invention also offers the advantage that it is susceptible of various modifications. Thus, the shape of the markers is not limited to rectangles, and instead other shaped markers may be used. Also the marker display circuits can be modified so as to increase or decrease the length of time the markers are displayed and also to change the vertical positions of the markers on the TV monitor screen. Different forms of imaging devices also may be used. For example, the imaging component of the invention may utilize a BBD semiconductor imaging device rather than a CCD solid state element, as suggested by U.S. Pat. No. 4,488,039. Similarly, the number of lenses in the objective lens unit and also in the zoom lens unit may be changed without affecting operation of the invention.

15 Other possible modifications and advantages of the invention will be obvious to persons skilled in the art.

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What is claimed is:

1. An endoscope apparatus comprising:
a handle assembly;
a tube having a distal end and a proximal end, said tube [being mounted within said outer tube and] having its proximal end anchored to said handle assembly;
an objective lens unit mounted in the distal end of said tube;
- 25 a shaft having a distal end and a proximal end, said shaft being disposed within and movable along the axis of said tube;
- 30 a solid state imaging device disposed within said tube and attached to said distal end of said shaft so as to be movable therewith along the axis of said tube, said imaging device having a light receiving surface (for receiving an image transmitted by said objective lens unit and being capable of generating an output signal representative of the image transmitted by said objective lens unit);
- 35 a zoom lens unit disposed within said tube between said objective lens unit and said imaging device (for transmitting images seen by said objective lens unit to said imaging device, said zoom lens unit being moveable along the axis of said tube relative to said objective lens unit so as to cause the (magnification of the image) passed by said objective lens unit to be changed in accordance with the axial position of said zoom lens unit in relation to said objective lens unit);
- 40 45 first and second drive means attached to said handle assembly;
a first motion-transmitting means coupling said first drive means to said shaft, whereby operation of said first drive means will cause axial movement of said imaging device relative to said objective lens unit;
- 50 55 a second motion-transmitting means coupling said second drive means to said zoom lens unit whereby operation of said second drive means will cause axial movement of said zoom lens unit relative to said objective lens unit;
- 60 control means for operating said first and second drive means;
display means responsive to said imaging device output signal for generating a video reproduction of the image passed by said objective lens unit; and
- 65 electronic means responsive to said imaging device output signal for causing said display means to generate a video image representative of the position of at least said zoom lens unit or said imaging device.

2. Apparatus according to claim 1 wherein said electronic means is adapted to cause said display means to generate a

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video image representative of the positions of both said zoom lens unit and said imaging device.

3. Apparatus according to claim 1 wherein said zoom lens unit is movable between a first minimum position and a second maximum position, and said electronic means is adapted to cause said display means to generate a first image representative of said minimum position of said zoom lens unit and a second image representative of said maximum position of said zoom lens unit. 5

4. Apparatus according to claim 3 wherein said electronic means is adapted to cause said display means to generate an additional image representative of the instantaneous position of said zoom lens unit. 10

5. Apparatus according to claim 1 wherein said imaging device is movable between a first minimum position and a second maximum position, and said electronic means is adapted to cause said display means to generate a first image representative of said minimum position of said imaging device and a second image representative of said maximum position of said imaging device. 15

6. Apparatus according to claim 5 wherein said electronic means is adapted to cause said display means to generate an additional image representative of the instantaneous position of said imaging device. 20

7. An endoscope apparatus comprising:

a handle assembly; 25
an outer tube having a distal end and proximal end, with said proximal end anchored to said handle assembly;

an inner tube having a distal end and a proximal end, said inner tube being mounted within said outer tube and having its proximal end anchored to said handle assembly; 30

an objective lens unit mounted in the distal end of said inner tube;

a shaft having a distal end and a proximal end, said shaft being disposed within and movable along the axis of 35 said inner tube;

a solid state imaging device disposed within said inner tube and attached to said distal end of said shaft so as to be movable therewith along the axis of said inner tube, said imaging device having a light-receiving surface for receiving an image transmitted by said objective lens unit and being capable of generating an output signal representative of the image transmitted by 40 said objective lens unit;

a zoom lens unit disposed within said inner tube between said objective lens unit and said imaging device, said zoom lens unit being moveable along the axis of said inner tube relative to said objective lens unit so as to cause the magnification of the image passed by said objective lens unit to be changed in accordance with the axial position of said zoom lens unit in relation to said objective lens unit; 45

first and second drive means attached to said handle assembly;

171,173 a first motion-transmitting means coupling said first drive [lens] 55
means to said shaft, whereby operation of said first drive means will cause axial movement of said imaging device relative to said objective lens unit;

a second motion-transmitting means coupling said second drive means to said zoom lens unit whereby operation of said second drive means will cause axial movement of said zoom lens unit relative to said objective lens unit and said zoom lens unit; 60

18 E I a space between said outer and inner tubes; 65
light transmitting means in said space for transmitting light to illuminate an object viewed by said objective lens unit;

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[means attached to said handle assembly for connecting said proximal end of said light transmitting means to a light source;]

control means for operating said first and second drive means;

display means responsive to said imaging device output signal for generating a video reproduction of the image passed by said objective lens unit; and

electronic means responsive to said imaging device output signal for

10 causing said display means to generate a video image representative of the position of at least said zoom lens unit or said imaging device.

8. Apparatus according to claim 7 wherein said objective lens unit and said zoom lens unit have a common optical axis.

15 axis.
9 Apparatus according to claim 7 further including light-

173171 Apparatus according to claim 1, characterized in that the light-transmitting means disposed in said space between said inner and outer tubes, wherein said light-transmitting means has a distal end and a proximal end with said distal end termi-

20 10. Apparatus according to claim 7 wherein said first and

second drive means comprise first and second reversible electrical motors respectively.

11. Apparatus according to claim 10 further including
25 user-operable switch means carried by said handle assembly
for selectively operating said first and second electrical
motors.

12. Apparatus according to claim 7 further comprising means for sensing the extent and direction of movement of said zoom lens unit and said imaging device relative to said objective lens unit and for producing output signals indicative of the extent and direction of said movement, and means for coupling said output signals to said control means for use in controlling the relative positions of said zoom lens unit and said imaging device so that said imaging device is positioned at the focal plane of said zoom lens unit, whereby the image seen by said objective lens and projected by said zoom lens unit is in focus at the image-receiving surface of said imaging device.

40 13. Apparatus according to claim 7 further comprising first and second means for sensing the extent and direction of movement of said zoom lens unit and said imaging device respectively relative to said objective lens unit and for producing first and second output signals respectively

45 indicative of the extent and direction of movement of said zoom lens unit and said imaging device respectively, and means for coupling said output signals to said control means for use in controlling the relative positions of said zoom lens unit and said imaging device so that at each position of said 50 zoom lens unit said imaging device is positioned at the focal plane of said zoom lens unit, whereby the image seen by said objective lens and projected by said zoom lens unit is in focus at the image-receiving surface of said imaging device.

55 14. An endoscope apparatus comprising:
an inner tube having a distal end and a proximal end; an
outer tube surrounding said inner tube;

a solid state imaging device mounted within and movable along said inner tube; an objective lens unit mounted within and fixed to the inner tube; and

65 said objective lens unit and said imaging device, a plurality of light-transmitting fibers disposed between said inner and outer tubes, said fibers extending substantially to the distal end of said inner tube so that light transmitted thereby will illuminate the objective field.

first bi-directional electromechanical means for moving said zoom lens unit along said inner tube toward or away from said objective lens unit, said first electromechanical means comprising a first reversible electrical motor having an output shaft and first gear means coupling said output shaft to said zoom lens unit, whereby energization of said first motor will cause movement of said zoom lens unit along said inner tube according to the mode of energization of said motor; and

second bidirectional electromechanical means for moving said imaging device along said inner tube toward or away from said objective lens unit and said zoom lens unit, said second electromechanical means comprising a second reversible electrical motor having an output shaft of said second electrical motor to said imaging device, whereby energization of said second motor will cause movement of said imaging device along said inner tube according to the mode of energization of said second motor.

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a solid state imaging device disposed within said tube and attached to said distal end of said shaft so as to be movable therewith along the axis of said tube, said imaging device having an ~~an~~ light receiving surface for receiving an image transmitted by said objective lens unit and being capable of generating an output signal representative of the image transmitted by said objective lens unit;

10 display means responsive to said imaging device output signal for generating a video reproduction of the image passed by said objective lens unit; and

15 means responsive to said imaging device output signal for causing said display means to generate a video image representative of the position of at least said zoom lens unit or said imaging device.

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